The comparison of different acoustic approaches in the simulation of human phonation

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ABSTRACT

The physical modeling and numerical simulation of the human phonation is very complex topic of ongoing research. Its numerical simulation is of quite importance in medicine today, see, e.g. [5]. In this coupled problem the three different physical fields the deformation of the vocal folds (elastic body), the fluid flow and the acoustics have to be considered with all relevant coupling terms. Thereby, we consider the coupling between the fluid and the structure in a strong sense, whereas the acoustics filed is computed by a forward coupling from the fluid flow.

The two-dimensional physical model of fluid-structure interaction problem is described by linear elasticity theory and by incompressible Navier-Stokes equations. In order to enable the change of domain shape in time, the arbitrary Lagrangian-Eulerian method is used. The sound sources are calculated by the Lighthill analogy or evaluated from perturbation equations [4, 2].

The numerical model is based on the finite element method, which is used for all three physical domains. For stabilization of the fluid flow simulation, the modified Streamline-Upwind/Petrov-Galerkin stabilization is used, [1]. The perfectly matched layer with inverse mapping is applied for acoustic free-field simulation, see [3].

Finally, the comparison of numerical results obtained by Lighthill analogy and by perturbation equations will be presented.

REFERENCES


